HVOF as a Hard Chrome Replacement

Jon L. Devereaux

AIR - 4.9.7.4

NADEP Jacksonville

Materials Engineer

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JAN 2006		**00-00-2006 to 00-00-2006**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
HVOF as a Hard Chrome Replacement	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Air Depot Jacksonville,AIR 4.9.7.4,Jacksonville,FL,32212**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
26th Replacement of Hard Chrome and Cadmium Plating Program Review Meeting, January 24-26, 2006, San Diego, CA. Sponsored by SERDP/ESTCP.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**40**	

HVOF as a Hard Chrome Replacement

Current Status of P-3 Main Landing Gear

HVOF MLG Piston installed 26 April 99 on VP-30 Aircraft BuNo 156522

850 Landings on HVOF coated MLG Piston (Aug 00)

HVOF Coated Piston removed from service Aug 2000 due to internal oil leak on ID-2 (NOT HVOF COATED)

HVOF Coated Strut repaired, sent back to VP-30 Installed on Aircraft 160284 STBD April 25, 2001

1,078 Total Landings on HVOF coated strut (8/23/01)

HVOF as a Hard Chrome Replacement

Current Status of P-3 Main Landing Gear

2,858 Total Landings on HVOF coated strut as of 30 Sept 03

Aircraft sent to Depot JAX for PDM on 13 August 2003

Aircraft returned to VP-30 on Feb. 6, 2004

3,329 Total Landings on HVOF coated strut as of 7 May 04

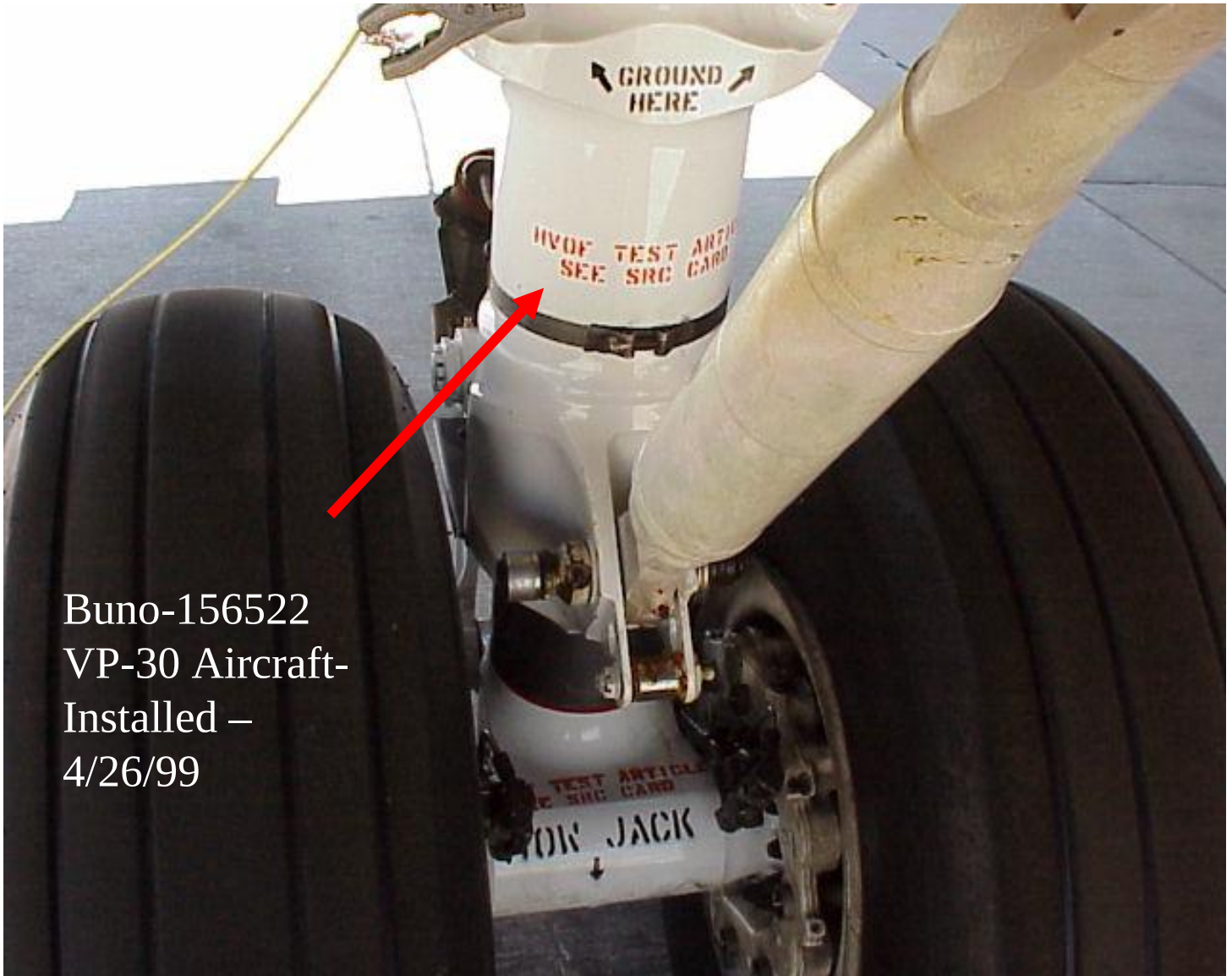
4,410 Total Landings on HVOF coated strut as of 1 March 05

6,378 Total Landings on HVOF coated strut as of 15 January 2006 when strut was removed & turned in to Supply IAW AFB 383

(Strut Assy S/N C30-1252 P/N 937958-103 R/H MLG)

HVOF as a Hard Chrome Replacement

HVOF as a Hard Chrome Replacement



Buno-156522
VP-30 Aircraft-Installed – 4/26/99

A/C 160284
Nov 14, 2003
2,858 Landings

HVOF as a Hard Chrome Replacement

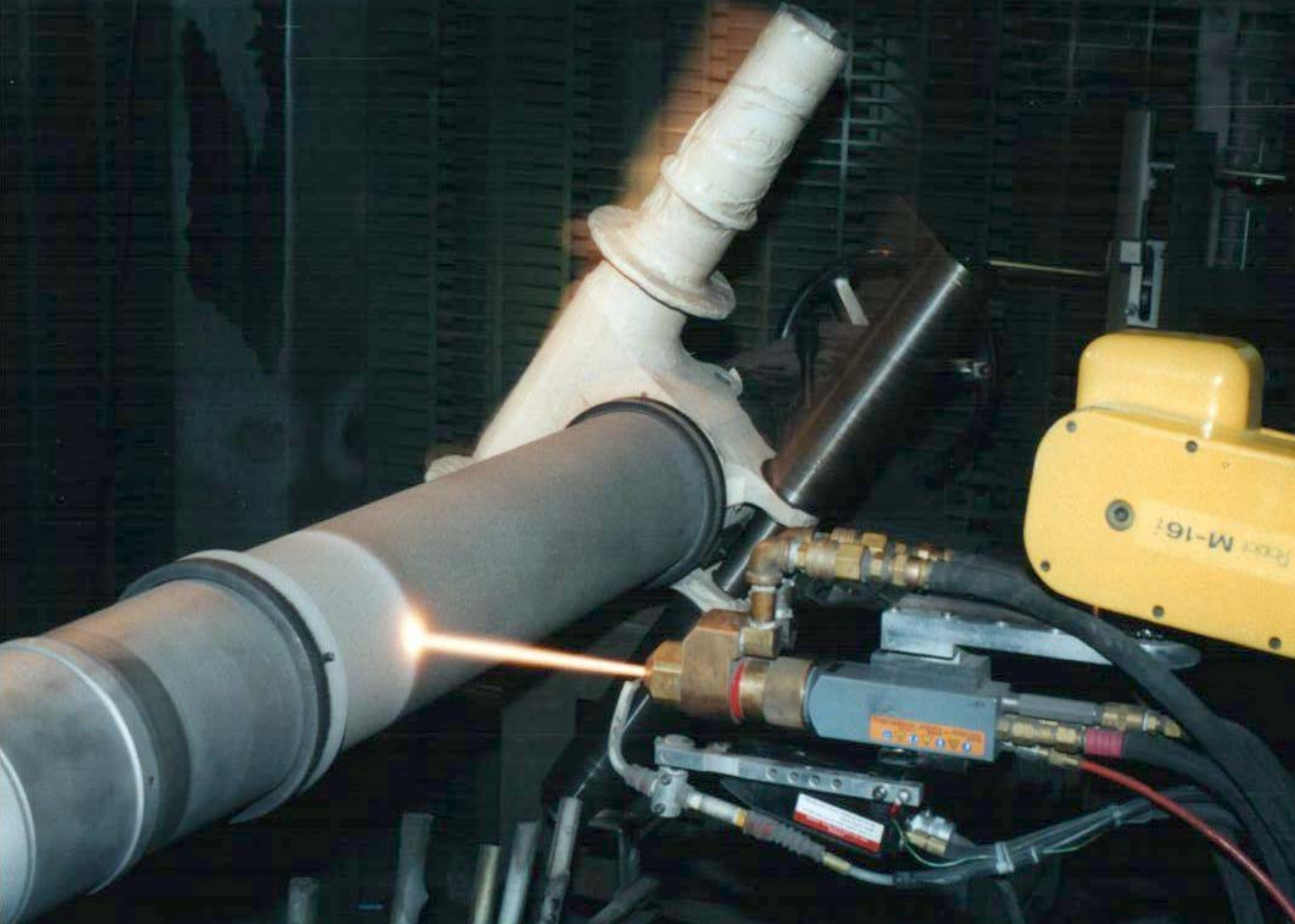
Second P-3 MLG Piston coated with HVOF WC/Co 83/17

- Tested in $70M P-3 aircraft SLAP/SLEP - Full Scale Fatigue Test
- R/H MLG chrome plated
- L/H MLG HVOF coated
- HVOF coating, grinding & processing of gear funded by Naval Research Lab (NRL)
- Testing started 30 August 2001 (24 month test)
- 26,000 CTH planned; ECD December 02 if all goes well
- Landing gear shows no sign of coating problems

HVOF as a Hard Chrome Replacement

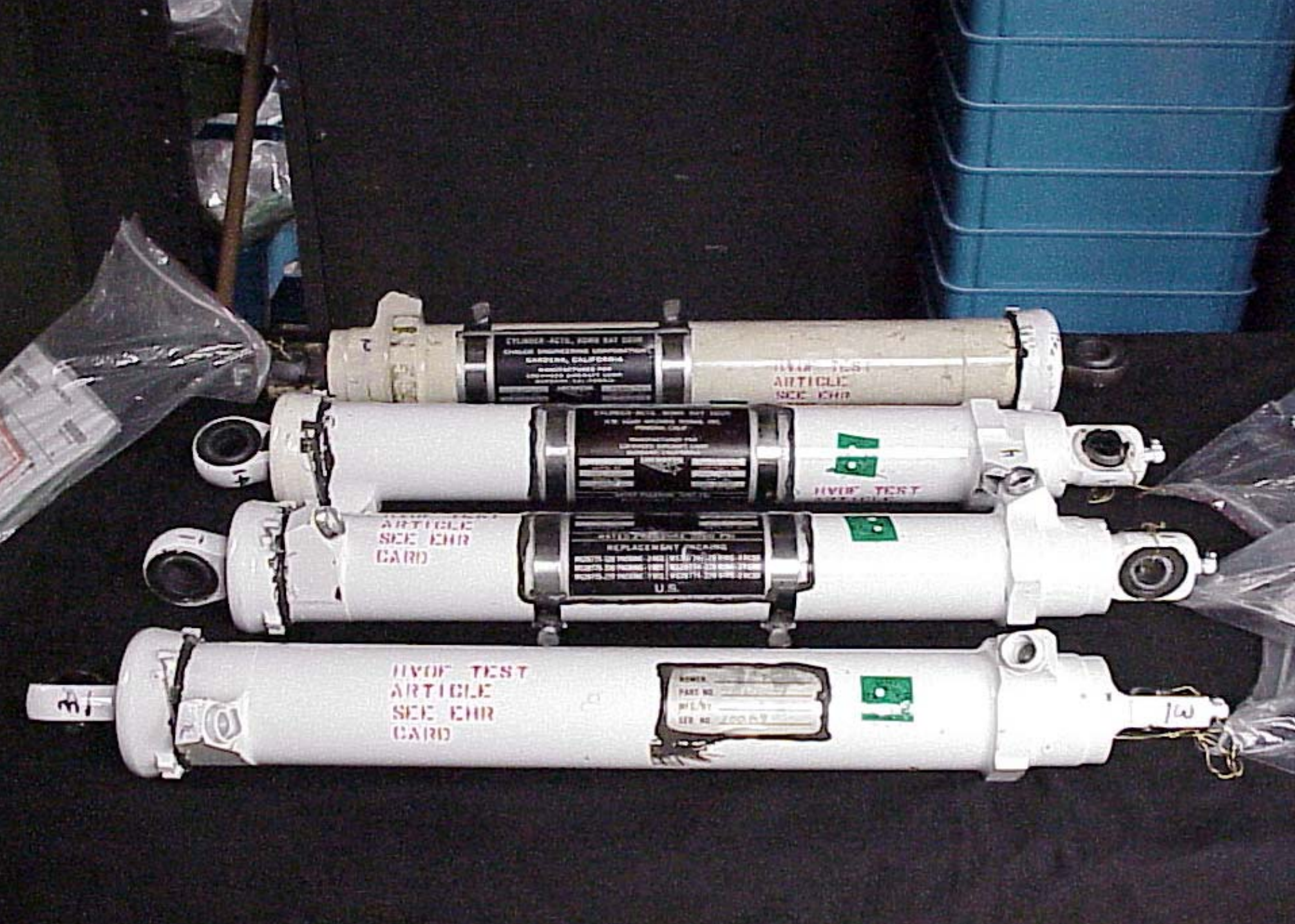
Second P-3 MLG Piston coated with HVOF WC/Co 83/17

- 26,000 CTH initially planned
- Test extended to 38,000 CTH - some of airframe not tested sufficiently
- 200-250K cycles on LG representing 47,000 Landings
- Test represents two fatigue lifetimes
- If this testing doesn't break the landing gear or HVOF coating, then nothing will! - NAVAIR Structures
- Landing gear shows no sign of failure or coating problems
- Test Completed with a "BANG!" on 4 March 2003
- Landing Gear removed April 2003 for inspection

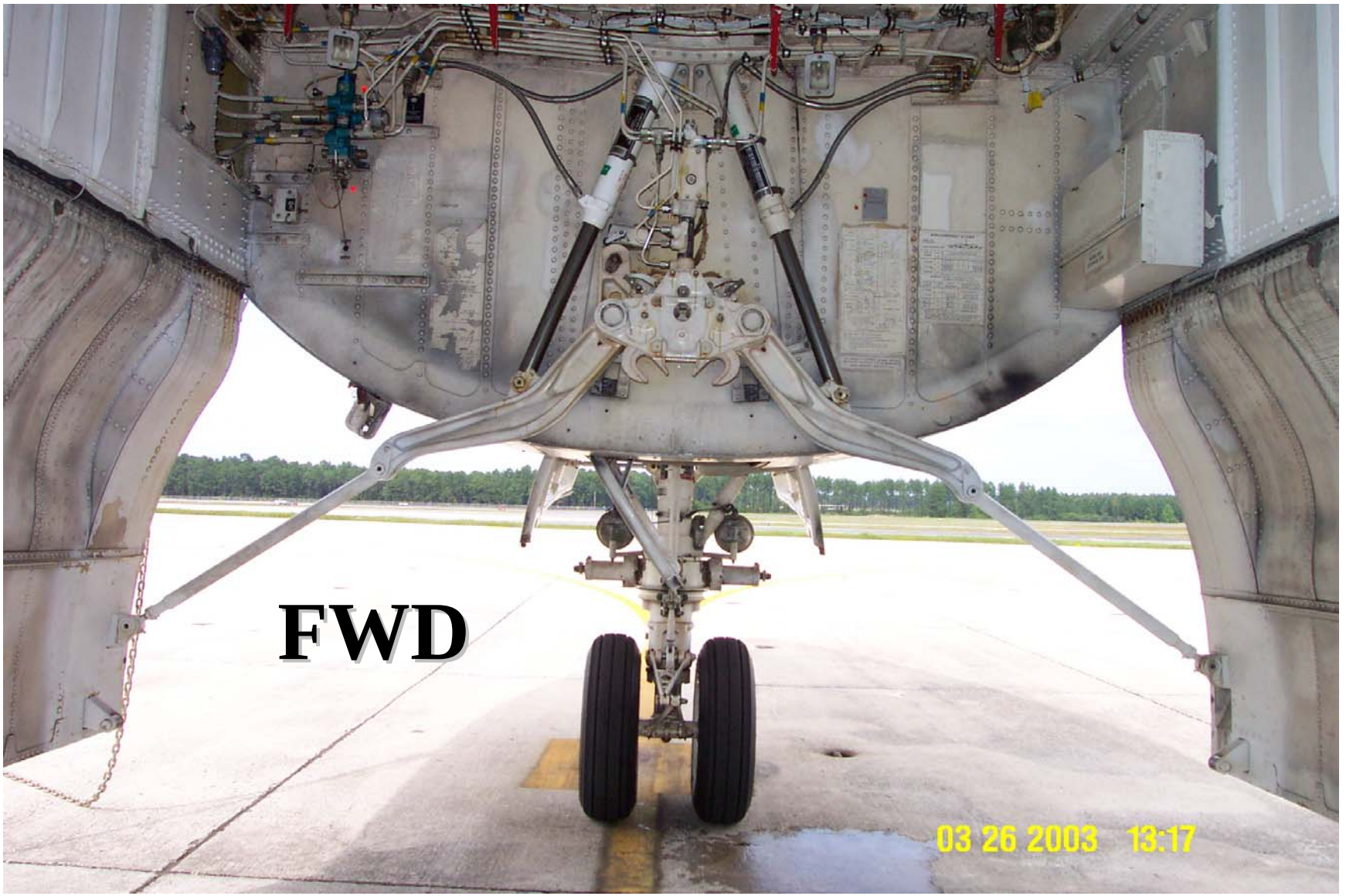

M-16

HVOF as a Hard Chrome Replacement

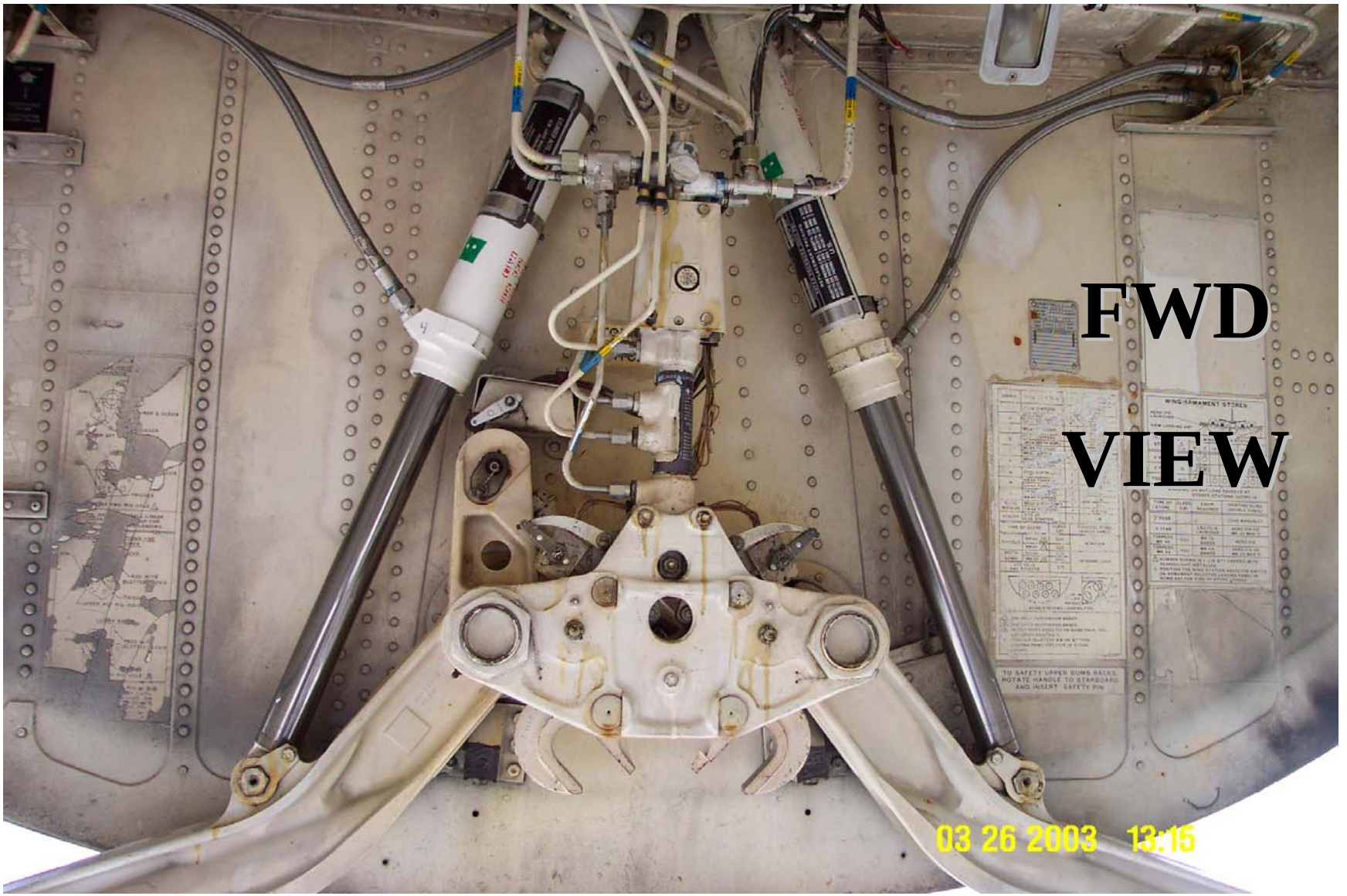
- P-3 Bomb Bay Door Actuator Pistons coated, ground, & superfinished
- Four HVOF coated P-3 Bomb Bay Door Actuator Assemblies RFI and installed on VP-30 Aircraft BuNo 156510 July 2001
- **1,363 Flight Hours on HVOF coated actuators as of (20 JAN 06)**
- 156510 currently at Greenville, SC
- Undergoing PDM & ESSI (started Sept. 05)
- Wing spar replacement on TLI bird (Time Life Indexed)
- Aircraft due back at VP-30 on 29 April 06


ARTICLE
SEE EHR
CARD
U.S.
ARTICLE
SEE EHR
CARD

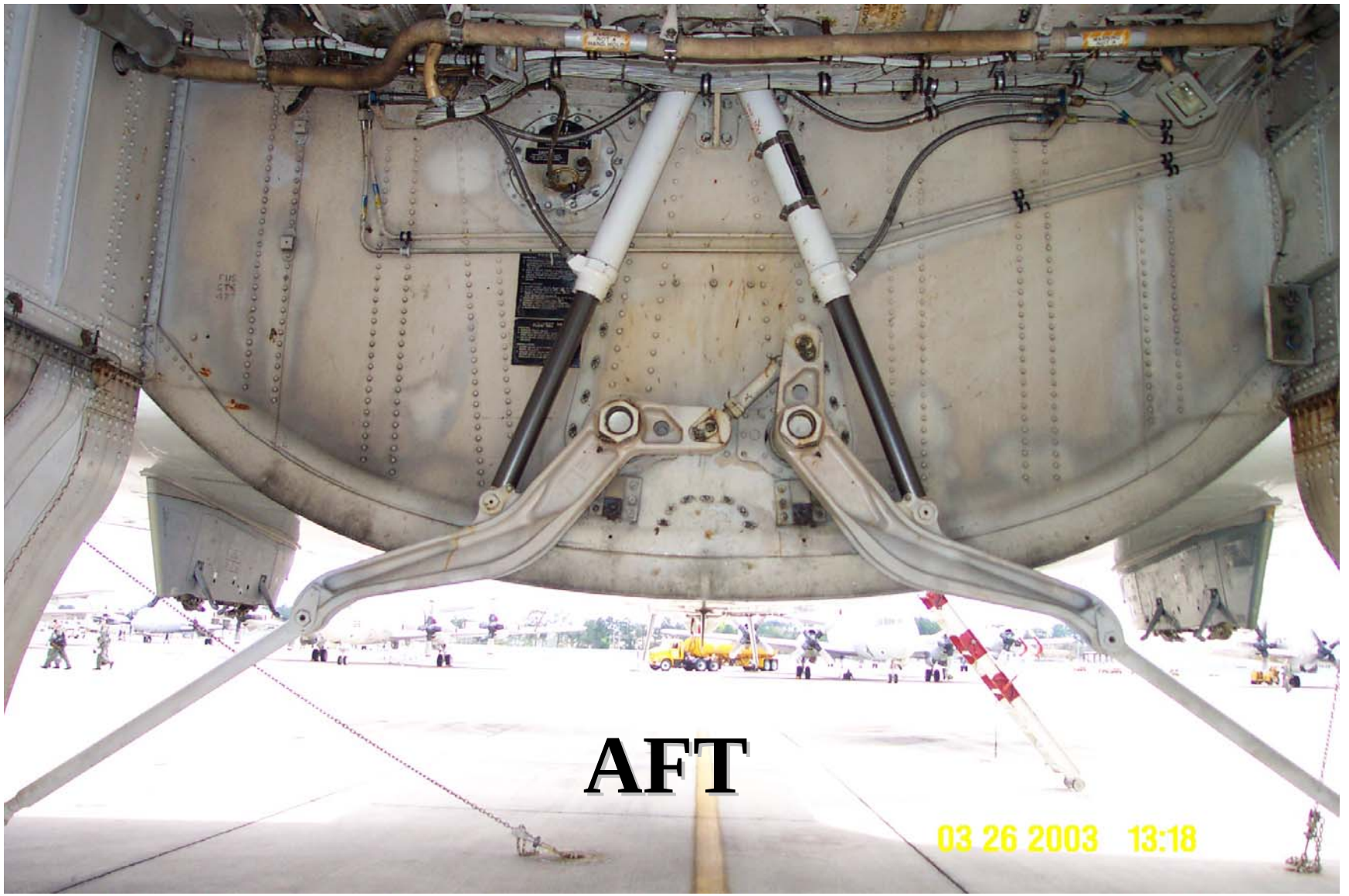
HVOF as a Hard Chrome Replacement



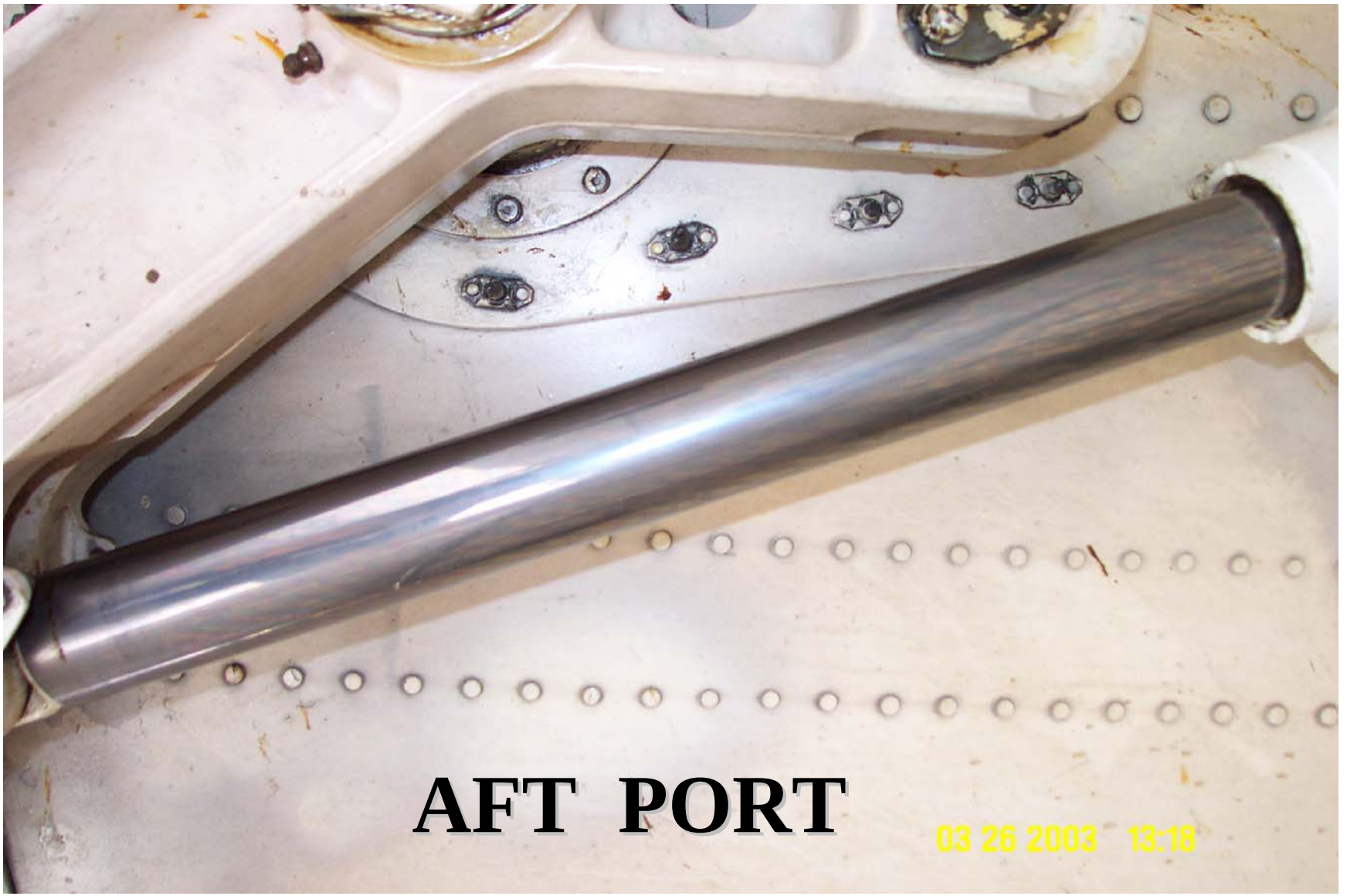
HVOF as a Hard Chrome Replacement



HVOF as a Hard Chrome Replacement



HVOF as a Hard Chrome Replacement



HVOF as a Hard Chrome Replacement

F/A-18 Horizontal Stabilator Piston Rod

P/N 3003130 (Vendor Code 93835) - Nat'l Water Lift

HVOF Coat short external end with WC/Co/Cr 86/10/4

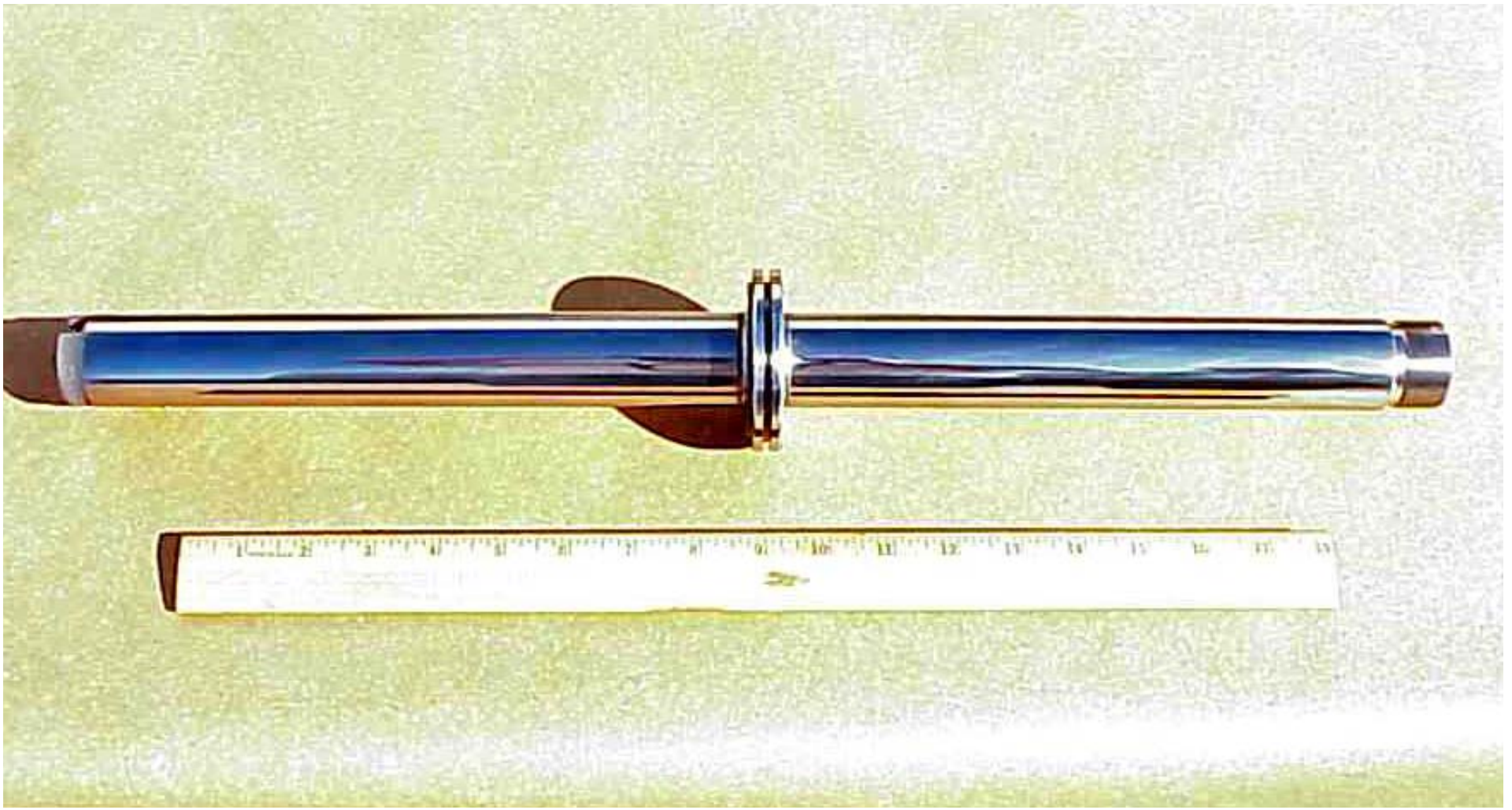
HVOF Coat longer internal end with WC/Co 83/17

Grind to 8 - 16 µin Ra finish

Superfinish to ≤ 2 µin Ra finish

Shipped to PAX Lab for additional Hydraulic Actuator seal compatibility testing on 15 Nov 02

HVOF as a Hard Chrome Replacement



HVOF as a Hard Chrome Replacement

HVOF as a Hard Chrome Replacement

F/A-18 Trailing Edge Flap (TEF) Actuator Piston Rod

P/N 303247-3 (Vendor Code 82106) - Parker Hannifin

HVOF Coat OD of Piston Rod with WC/Co/Cr 86/10/4

Grind to 8 - 16 µin Ra finish

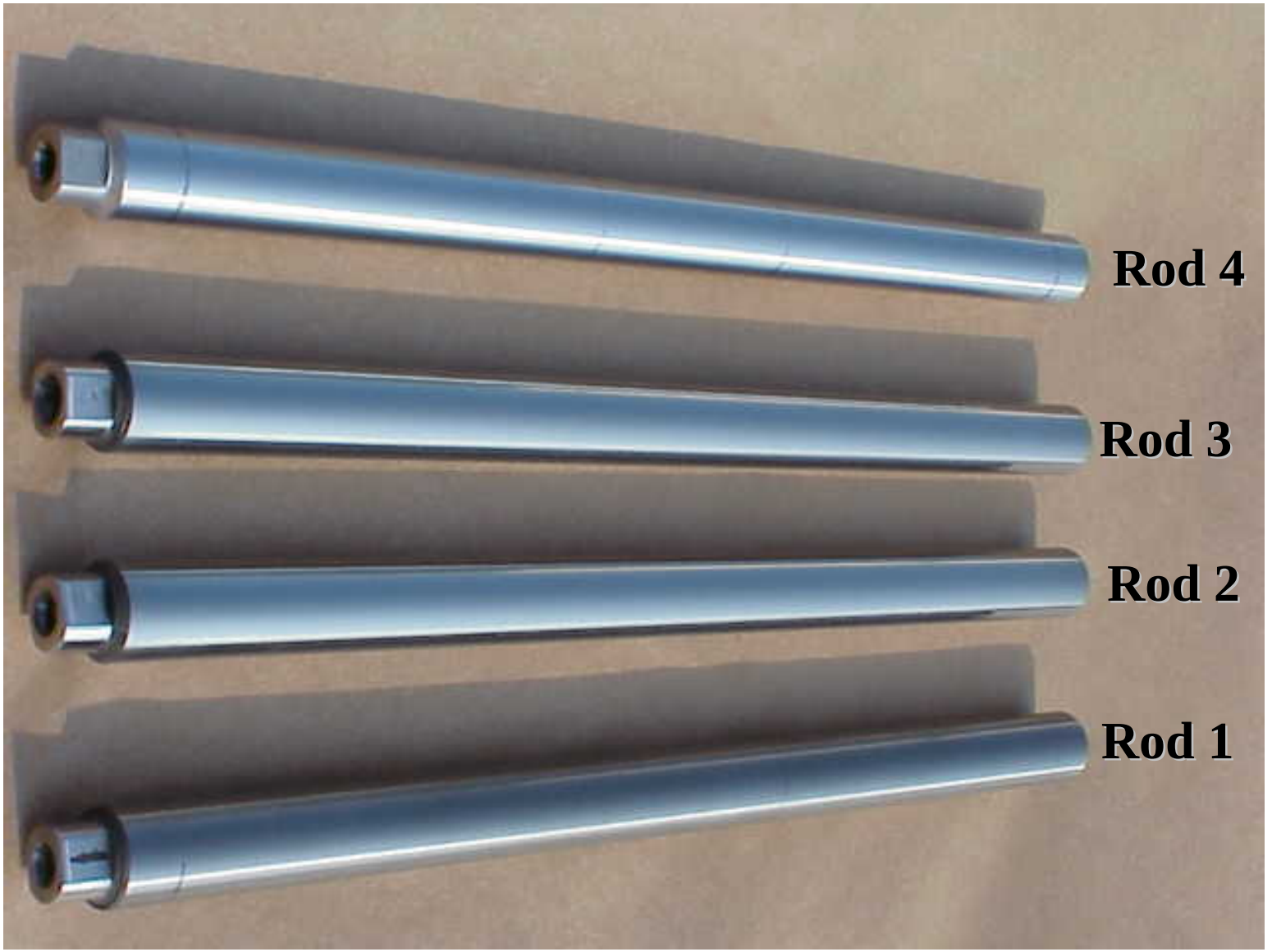
Superfinish to ≤ 2 µin Ra finish

Shipped to NADEP NORIS for additional Hydraulic Actuator seal compatibility testing on 20 Mar 03

Second F/A-18 TEF Actuator Piston Rod shipped to NADEP NORIS 16 Sept 03 for build-up and then ship to PAX for additional Hydraulic Actuator seal compatibility testing

HVOF as a Hard Chrome Replacement

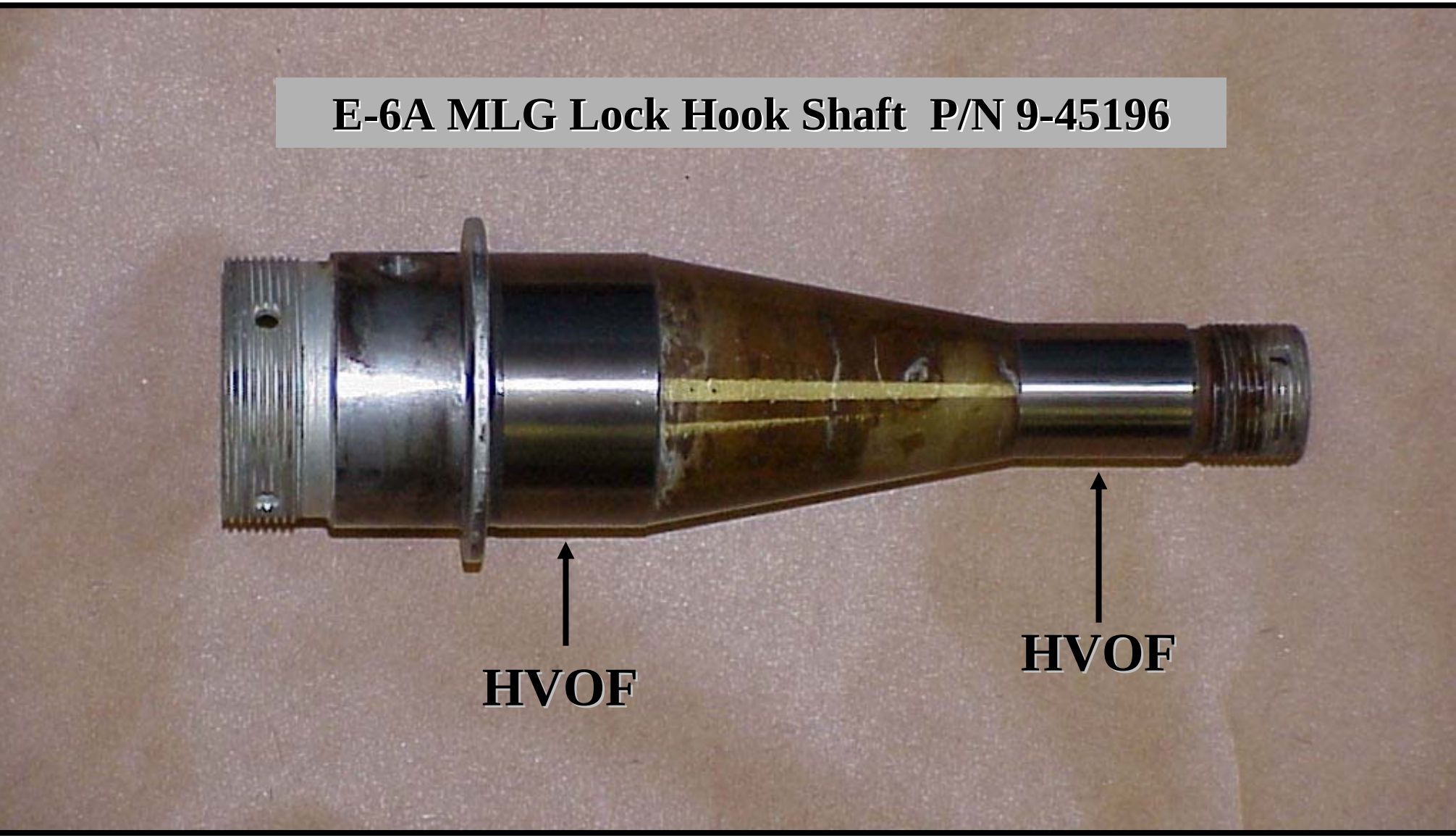
HVOF as a Hard Chrome Replacement



HCAT Hydraulic Actuator JTP Part II Phase 1 1” dia. Test rod

Superfinished at NADEP JAX

HVOF as a Hard Chrome Replacement



HVOF as a Hard Chrome Replacement E-6A Main Landing Gear

Two HVOF coated E-6A MLG Uplock Hook Shafts installed 10 March 99 on A/C 164388

6,019.5 Flight Hours (Nov 2005)

4,381 Landings (Nov 2005)

HVOF Shafts to be removed during LG O/H 9-29-2008

One HVOF coated E-6A MLG Uplock Hook Shaft installed on Aircraft 162784 in Feb. 2000

6,235 Flight Hours (Nov 2005)

4,377 Landings (Nov 2005)

HVOF Shaft to be removed during LG O/H 12-3-2007

HVOF as a Hard Chrome Replacement

HVOF coated R/H EA-6B MLG Strut Assy.

P/N 1707B00-02 S/N BFG 5008

HVOF as a Hard Chrome Replacement

Current Status of HVOF Coated

EA-6B Main Landing Gear Strut Assy.

EA-6B MLG alloy is 4330 V-mod
220-240 KSI UTS 180-185 KSI Yield Strength

MLG Piston coated Oct. 99

Depot processing completed Dec. 99

Flight clearance requested Jan 2000

NAVAIR Structures (AIR-4.3.3.1) gives approval to move ahead with flight clearance request for HVOF coated Strut in Mtg. At PAX River on 19 August 2003

HVOF as a Hard Chrome Replacement

Flight Clearance Message issued DTG 102001Z DEC 03

HVOF coated Strut Assy re-inducted into Depot Landing Gear Shop for repeat of final pressure check and leak test prior to being issued as RFI to aircraft line (Feb 2004)

Aircraft 163395 identified

HVOF coated MLG Strut Assy installed on EA-6B Aircraft 163395 June 04

FIRST FLIGHT w/ HVOF strut 13 July 2004

Aircraft delivered to Whidbey Is. 20 July 2004

HVOF as a Hard Chrome Replacement

HVOF coated

EA-6B MLG

Strut Assy.

P/N 1707B00-02

S/N BFG 5008

Aircraft

163395

July 13, 2004

09:34 a.m.

HVOF as a Hard Chrome Replacement

HVOF coated

EA-6B MLG

Strut Assy.

P/N 1707B00-02

S/N BFG 5008

Aircraft

163395

July 13, 2004

09:34 a.m.

HVOF as a Hard Chrome Replacement

HVOF coated

EA-6B MLG

Strut Assy.

P/N 1707B00-02

S/N BFG 5008

Aircraft

163395

July 13, 2004

09:34 a.m.

HVOF as a Hard Chrome Replacement

HVOF coated

EA-6B MLG

Strut Assy.

P/N 1707B00-02

S/N BFG 5008

Aircraft

163395

July 13, 2004

HVOF as a Hard Chrome Replacement

Aircraft delivered to Whidbey Is. 20 July 2004

1st Carrier Landing 9-14-04 aboard USS Carl Vinson

Returned to NAS Whidbey Is. 10-3-2004

30 Cats & 30 Traps during 3 week work-ups

Deployed again to USS Carl Vinson 1-20-2005

Successfully completed World Cruise 8-8-2005

Latest info 330 Total Landings on HVOF coated Strut

162 Cat Shots; 164 Traps (19 December 2005)

HVOF as a Hard Chrome Replacement

HVOF as a Hard Chrome Replacement

The HVOF coated MLG Strut Assy has now undergone the severest operational in-service testing during this world cruise which included combat operations in an active zone.

This strut continues to gather valuable dem/val data for this technology insertion effort.

Upon successful completion of this world cruise, the HVOF coated MLG Strut Assy has now accumulated a TOTAL of 330 Landings, including 164 Traps (arrested landings) and 162 Cat Shots (catapult launches) as of 19 Dec 2005.

Aircraft deployed to Alaska 5 – 21 Oct 2005

Aircraft transferred to VAQ-209 on 19 Dec 05


VAQ-138 EA-6B A/C 502
First carrier landing with HVOF coated
MLG Strut Assy installed at NADEP JAX
USS Carl Vinson 9-14-04


NO SMO


NAVAIR Approvals

Authorization to implement HVOF on P-3 NLG & MLG Pistons and Bomb Bay Door Actuators on May 28, 2003

Successfully produced NAVAIR Materials Engineering HVOF Coating Implementation Guidance Document on March 3, 2005 mtg. @ Cherry Point

HVOF as a Hard Chrome Replacement

AMS 2448 - HVOF Coating Application Specification
Published by SAE in October 2004

AMS 2449 – HVOF Grinding Specification
Published by SAE in August 2004

AMS 7881 – Tungsten Carbide-Cobalt Powder
Specification published by SAE in April 2003

AMS 7882 – Tungsten Carbide-Cobalt Chrome Powder
Specification published by SAE in April 2003

HVOF as a Hard Chrome Replacement

AMS 7881 & AMS 7882 – Powder Specifications

Revision A is currently being drafted to include changes that will accommodate Praxair/Tafa, Stellite, & other powders

Revision A to each powder spec will be presented to AMEC for balloting by Don Parker next week

AMEC Mtg. 189 @ Asilomar, Pacific Grove, CA

1 – 3 February 2006

AMEC will then forward Revision A specs to Committee B for approval

Donald.S.Parker@nasa.gov

HVOF as a Hard Chrome Replacement